

AMENDMENTS TO THE CLAIMS

Claim 1 (Currently Amended): A nonaqueous electrolyte comprising a nonaqueous solvent and a solute dissolved in said nonaqueous solvent,

wherein said nonaqueous solvent contains a main solvent including 20 to 50% by volume of ethylene carbonate and 40 to 80% by volume of  $\gamma$ -butyrolactone and a third solvent comprising a solvent P including at least one kind of solvent selected from the group consisting of ethylene sulfite, phenylethylene carbonate, 2-methylfuran, furan, thiophene, catechol carbonate and vinyl ethylene carbonate, and a solvent Q including at least one selected from the group consisting of propylene carbonate, vinylene carbonate, diethyl carbonate, dimethyl carbonate, ethyl methyl carbonate,  $\gamma$ -valerolactone, methyl propionate and ethyl propionate; and

wherein a content of the third solvent in the nonaqueous solvent falls within a range of 0.01 to 5% by weight.

Claims 2-3 (Canceled)

Claim 4 (Currently Amended): A nonaqueous electrolyte secondary battery comprising a case having a wall thickness not larger than 0.3 mm, a positive electrode provided in said case, a negative electrode provided in said case; and a nonaqueous electrolyte provided in said case and comprising a nonaqueous solvent and a solute dissolved in said nonaqueous solvent,

wherein said nonaqueous solvent contains a main solvent including 20 to 50% by volume of ethylene carbonate and 40 to 80% by volume of  $\gamma$ -butyrolactone and a third solvent comprising a solvent P including at least one ~~kind of solvent~~ selected from the group consisting of ethylene sulfite, phenylethylene carbonate, ~~2-methylfuran, furan, thiophene,~~ catechol carbonate and vinyl ethylene carbonate, and a solvent Q including at least one selected from the group consisting of propylene carbonate, vinylene carbonate, diethyl carbonate, dimethyl carbonate, ethyl methyl carbonate,  $\gamma$ -valerolactone, methyl propionate and ethyl propionate; and

wherein a content of the third solvent in the nonaqueous solvent falls within a range of 0.01 to 5% by weight.

Claim 5 (Original): The nonaqueous electrolyte secondary battery according to claim 4, wherein said nonaqueous electrolyte is substantially in the form of a liquid or a gel.

Claim 6 (Currently Amended): The nonaqueous electrolyte secondary battery according to claim 4, wherein the amount of said third solvent based on the nonaqueous solvent is ~~not larger than~~ 0.1 to 5% by weight.

Claim 7 (Currently Amended): The nonaqueous electrolyte secondary battery according to claim 4, wherein the amount of said third solvent based on the nonaqueous solvent is ~~not larger than~~ 0.1 to 3% by weight in the case where said third solvent includes at least one kind of solvent selected from the group consisting of phenylethylene carbonate, ~~2-methylfuran, furan, thiophene,~~ catechol carbonate and vinyl ethylene carbonate.

Claims 8-10 (Canceled)

Claim 11 (Currently Amended): The nonaqueous electrolyte secondary battery according to claim 4, wherein ~~said third solvent further includes at least one kind of solvent selected from the group consisting of propylene carbonate, vinylene carbonate, diethyl carbonate, dimethyl carbonate, ethyl methyl carbonate,  $\gamma$ -valerolactone, methyl propionate and ethyl propionate,~~ the amount of said third solvent based on the nonaqueous solvent is ~~not larger than 5% by weight,~~ and the amount of propylene carbonate based on the nonaqueous electrolyte solvent is smaller than 2% by volume (including 0% by volume).

Claim 12 (Canceled)

Claim 13 (Original): The nonaqueous electrolyte secondary battery according to claim 4, wherein said solute includes at least one lithium salt selected from the group consisting of  $\text{LiClO}_4$ ,  $\text{LiPF}_6$ ,  $\text{LiBF}_4$ ,  $\text{LiAsF}_6$ ,  $\text{LiCF}_3\text{SO}_3$ ,  $\text{LiN}(\text{CF}_3\text{SO}_2)_2$  and  $\text{LiN}(\text{C}_2\text{F}_5\text{SO}_2)_2$ .

Claim 14 (Original): The nonaqueous electrolyte secondary battery according to claim 4, wherein said negative electrode contains a carbonaceous material capable of absorbing-desorbing lithium ions.

Claim 15 (Original): The nonaqueous electrolyte secondary battery according to claim 14, wherein said carbonaceous material includes mesophase pitch based carbon fiber.

Claim 16 (Original): The nonaqueous electrolyte secondary battery according to claim 4, wherein said case is formed essentially of a metal plate, a metal film or a sheet including a resin layer.

Claim 17 (Currently Amended): A nonaqueous electrolyte secondary battery comprising a case having a wall thickness not larger than 0.3 mm, a positive electrode provided in said case, a negative electrode provided in said case, and a nonaqueous electrolyte layer arranged between said positive electrode and said negative electrode, and said nonaqueous electrolyte layer containing a nonaqueous electrolyte and a polymer capable of gelling said nonaqueous electrolyte,

wherein said nonaqueous electrolyte contains a nonaqueous solvent including a main solvent including 20% to 50% by volume of ethylene carbonate and 40% to 80% by volume of  $\gamma$ -butyrolactone and a third solvent comprising a solvent P including at least one kind of solvent selected from the group consisting of ethylene sulfite, phenylethylene carbonate, 2-methylfuran, furan, thiophene, catechol carbonate and vinyl ethylene carbonate, and a solvent Q including at least one selected from the group consisting of propylene carbonate, vinylene carbonate, diethyl carbonate, dimethyl carbonate, ethyl methyl carbonate,  $\gamma$ -valerolactone, methyl propionate and ethyl propionate; and

wherein a content of the third solvent in the nonaqueous solvent falls within a range of 0.01 to 5% by weight.

Claim 18 (Currently Amended): The nonaqueous electrolyte secondary battery according to claim 17, wherein the amount of said third solvent based on the nonaqueous solvent is ~~not larger than~~ 0.1 to 5% by weight.

Claim 19 (Currently Amended): The nonaqueous electrolyte secondary battery according to claim 17, wherein the amount of said third solvent based on the nonaqueous solvent is ~~not larger than~~ 0.1 to 3% by weight in the case where said third solvent includes at least one kind of solvent selected from the group consisting of phenylethylene carbonate, 2-methylfuran, furan, thiophene, catechol carbonate and vinyl ethylene carbonate.

Claims 20-22 (Canceled)

Claim 23 (Currently Amended): The nonaqueous electrolyte secondary battery according to claim 17, wherein ~~said third solvent further includes at least one kind of solvent selected from the group consisting of propylene carbonate, vinylene carbonate, diethyl carbonate, dimethyl carbonate, ethyl methyl carbonate,  $\gamma$ -valerolactone, methyl propionate and ethyl propionate, the amount of said third solvent based on the nonaqueous solvent is not larger than 5% by weight, and the amount of propylene carbonate based on the nonaqueous solvent is smaller than 2% by volume (including 0% by volume).~~

Claims 24-32 (Canceled)

Claim 33 (New): The nonaqueous electrolyte according to claim 1, wherein the solvent P of the third solvent is vinyl ethylene carbonate.

Claim 34 (New): The nonaqueous electrolyte according to Claim 33, wherein the solvent Q includes vinylene carbonate and at least one selected from the group consisting of diethyl carbonate, dimethyl carbonate, ethyl methyl carbonate,  $\gamma$ -valerolactone, methyl propionate and ethyl propionate.

Claim 35 (New): The nonaqueous electrolyte secondary battery according to claim 4, wherein the solvent P of the third solvent is vinylethylene carbonate.

Claim 36 (New): The nonaqueous electrolyte secondary battery according to Claim 35, wherein the solvent Q includes vinylene carbonate and at least one selected from the group consisting of diethyl carbonate, dimethyl carbonate, ethyl methyl carbonate,  $\gamma$ -valerolactone, methyl propionate and ethyl propionate.

### SUPPORT FOR THE AMENDMENT

This Amendment cancels Claims 2-3, 8-10, 12, 20-22, 24-32 and 31-32; amends Claims 1, 4, 6-7, 11, 17-19 and 23; and adds new Claims 33-36. Support for the amendments is found in the specification and claims as originally filed. In particular, support for Claims 1, 4 and 17 is found in Claims 10-11 and 22-23, and in the specification at least at page 28, lines 4-27; and page 31, line 19 to page 34, line 16. Support for Claims 6 and 18 is found in the specification at least at page 30, lines 4-5, 16 and 26. Support for Claims 7 and 19 is found in Claims 10 and 22 and in the specification at least at page 30, lines 4-5, 16 and 26. Support for Claim 11 is found in the specification at least at page 33, line 26; page 34, line 8; page 79, lines 9-15; and page 81, Table 11. Support for new Claims 33 and 35 is found in the specification at least at page 82, lines 14-18. Support for Claims 34 and 36 is found in the specification at least at page 34, lines 13-16 and page 82, lines 14-21. No new matter would be introduced by entry of these amendments.

Upon entry of these amendments, Claims 1, 4-7, 11, 13-19, 23 and 33-36 will be pending in this application. Claims 1, 4 and 17 are independent.

### REQUEST FOR RECONSIDERATION

Applicants respectfully request entry of the foregoing and reexamination and reconsideration of the application, as amended, in light of the remarks that follow.

Applicants thank the Examiner for the courtesies extended to their representative during the March 11, 2004, personal interview.

As discussed at the personal interview, the present invention provides a nonaqueous electrolyte capable of improving the high temperature charge-discharge cycle characteristics of a nonaqueous electrolyte secondary battery. By combining in the electrolyte ethylene carbonate,  $\gamma$ -butyrolactone, and the third solvent containing solvents P and Q, where the

content of the third solvent is 0.01 to 5% by weight, the present invention achieves in nonaqueous electrolyte secondary batteries a significant improvement at high temperatures in cycle life and capacity retention rate after 200 cycles. See, e.g., specification at pages 81-82, further discussed below.

Claims 1 and 25 are rejected under 35 U.S.C. § 102(a) over JP 2001-126761 ("Kotado"). In addition, Claims 4-7, 9-24, 26-28 and 31-32 are rejected under 35 U.S.C. § 103(a) over Kotado in view of U.S. Patent No. 6,048,639 ("Sonozaki").

For the Examiner's convenience, an English-language translation of Kotado is attached.

Kotado provides a nonaqueous electrolyte secondary battery comprising a non-aqueous solvent containing vinylene carbonate and 90% by weight or more of one or more solvents selected from solvents having a relative dielectric constant of not smaller than 25. Kotado at abstract. Kotado discloses that the electrolyte can also include ethylene carbonate, propylene carbonate, butylene carbonate,  $\gamma$ -butyrolactone,  $\gamma$ -valerolactone, sulfolane, 3-methylsulfolane, dimethylsulfoxide, dimethyl carbonate, diethyl carbonate, di-n-propyl carbonate, ethylmethyl carbonate, a tetrahydrofuran, 2-methyl tetrahydrofuran, dimethoxy ethane, methyl acetate and ethyl propionate. Kotado at [0015] and [0020]. Kotado discloses that these solvents may be added in such a combination that the flash point of the non-aqueous solvents, including those added, is not lower than 70°C. Kotada at [0020].

However, Kotado's examples include only three solvents. Kotado provides no motivation to select the combination of four solvents (ethylene carbonate,  $\gamma$ -butyrolactone, and two specified third solvents) present in the electrolyte of the present invention. As a result, Kotado fails to suggest the limitations of independent Claims 1, 4 and 17 of an electrolyte including (i) ethylene carbonate, (ii)  $\gamma$ -butyrolactone, and a third solvent



comprising (iii) "a solvent P including at least one selected from the group consisting of ethylene sulfite, phenylethylene carbonate, catechol carbonate and vinyl ethylene carbonate", and (iv) "a solvent Q including at least one selected from the group consisting of propylene carbonate, vinylene carbonate, diethyl carbonate, dimethyl carbonate, ethyl methyl carbonate,  $\gamma$ -valerolactone, methyl propionate and ethyl propionate" where "a content of the third solvent in the nonaqueous solvent falls within a range of 0.01 to 5% by weight".

Sonozaki fails to remedy the deficiencies of Kotado. The Office Action relies upon Sonozaki for suggesting batteries with casings having walls less than 0.3 mm in thickness.

Because the cited prior art fails to suggest all the limitations of the claimed invention, the prior art rejections should be withdrawn.

Any *prima facie* case of obviousness based on the cited prior art is rebutted by the significant improvement in high temperature cycle life and capacity retention rate after 200 cycles achieved according to the present invention using an electrolyte with ethylene carbonate,  $\gamma$ -butyrolactone, and two specified third solvents. See specification at page 81, Table 11, reproduced below.

Table 11

	Nonaqueous solvent	Solute	Solute concentration (mol/L)	Maximum discharge capacity (Ah)	Capacity retention rate after 200 cycles at 45°C (%)	Swelling (%)
Example 1	99.5wt% of main solvent (EC + BL at volume ratio of 33:67) and 0.5 wt% of ES;	LiBF <sub>4</sub>	1.5	0.52	20	1
Example 47	99wt% of main solvent (EC + BL at volume ratio of 33:67), 0.5wt% of ES and 0.5 wt% of VC;	LiBF <sub>4</sub>	1.5	0.52	45	2
Example 48	98wt% of main solvent (EC + BL at volume ratio of 33:67), 0.5 wt% of ES, 1wt% of PC and 0.5wt% of VC;	LiBF <sub>4</sub>	1.5	0.52	53	4
Example 49	98wt% of main solvent (EC + BL at volume ratio of 33:67), 0.5 wt% of ES, 1wt% of PC and 0.5wt% of DEC;	LiBF <sub>4</sub>	1.5	0.52	37	4
Example 7	99.5wt% of main solvent (EC + BL at volume ratio of 33:67) and 0.5 wt% of VEC;	LiBF <sub>4</sub>	1.5	0.52	25	1
Example 50	99wt% of main solvent (EC + BL at volume ratio of 33:67), 0.5 wt% of VEC, and 0.5wt% of VC;	LiBF <sub>4</sub>	1.5	0.52	47	2
Example 51	98wt% of main solvent (EC + BL at volume ratio of 33:67), 0.5 wt% of VEC, 1wt% of PC and 0.5wt% of VC;	LiBF <sub>4</sub>	1.5	0.52	55	4
Example 52	98wt% of main solvent (EC + BL at volume ratio of 33:67), 0.5 wt% of VEC, 1wt% of PC and 0.5wt% of DEC;	LiBF <sub>4</sub>	1.5	0.52	35	3

(Note: "EC" = ethylene carbonate; "BL" =  $\gamma$ -butyrolactone; "ES" = ethylene sulfite; "VEC" = vinylethylene carbonate; "VC" = vinylene carbonate; "PC" = propylene carbonate; "DEC" = diethyl carbonate").

As discussed in the specification at page 82, the batteries of Examples 47-49, which include the specific combination of four solvents of the present invention, exhibit significantly higher capacity retention rates after 200 cycles at 45°C than the battery of Example 1 with only three solvents. Similarly, the batteries of Examples 50-52, which include the specific combination of four solvents of the present invention, exhibit significantly higher capacity retention rates after 200 cycles at 45°C than the battery of Example 7 with only three solvents. Because the cited prior art fails to suggest the significant

improvement in high temperature cycle life and capacity retention rate achieved using the specific combination of four solvents of the present invention, any *prima facie* case of obviousness based on the cited prior art is rebutted. For this additional reason, the prior art rejections should be withdrawn.

Applicants respectfully request that the Examiner acknowledge consideration of the references cited in the Information Disclosure Statements filed December 27, 2001, and February 2, 2004. For the Examiner's convenience, a copy of each of the associated Forms PTO-1449 and the date-stamped filing receipts are attached.


In view of the foregoing amendments and remarks, Applicants respectfully submit that the application is in condition for allowance. Applicants respectfully request favorable consideration and prompt allowance of the application.

Should the Examiner believe that anything further is necessary in order to place the application in even better condition for allowance, the Examiner is invited to contact Applicants' undersigned attorney at the telephone number listed below.

Respectfully submitted,

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Attachments:

English-language translation of JP 2001-126761 ("Kotado")

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